Bull. Southern California Acad. Sci.
118(2), 2019, pp. 79–86

Behavior of Young-of-the-Year Giant Sea Bass, *Stereolepis gigas*, off the Sandy Beaches of Southern California

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Abstract.—We made extensive observations in the shallows off sandy beaches along the southern California coastline from 2013-2018 using SCUBA. The common diurnal behavior of young-of-the-year (YOY) of giant sea bass, *Stereolepis gigas*, were documented, in detail, and categorized while they occupied their unique nursery areas. We identified and described the frequently observed behaviors referred to as 1) "kelping", 2) "resting", 3) "traveling", and 4) "burying". Finally, through direct observation, mysid shrimp were confirmed as the primary diet of young-of-the-year of the giant sea bass off southern California. This is the first study to provide a behavioral overview of the YOY of this internationally listed, endangered species, and it bridges important gaps in our understanding of their early life history.

Until recently, we knew little about the basic biology and life history of *Stereolepis gigas* because the over-exploitation of their fishery in the early 1900s depressed their populations and limited research (*c.f.* House et al. 2016). Documentation of the early life history of the ecologically and once economically-important giant sea bass is critical for both the successful management of that fishery and to provide a more complete baseline to aid with future studies of giant sea bass. Early developmental processes and recruitment patterns are crucial for completing the life history of any species, allowing us to make increasingly intelligent decisions about fisheries management policies and future conservation efforts, protect nursery sites, and encourage further studies of this species (Cailliet et al. 1996, Craig et al. 1999).

Quite the opposite of their rotund and dark adult counterparts, the young-of-the-year (YOY) giant sea bass are very small, terete but laterally compressed (perch-shaped), and depending on their age, their color phases transition through black, brown, then orange (Benseman and Allen 2018). Divers usually observe them as a bright orange or reddish fish with black and white spots, enlarged black pelvic fins, and transparent pectoral, caudal, and anal fins (Love 2011). The frequent low visibility in their preferred habitat, their unique shape, coloration, and behaviors that allow them to remain inconspicuous are adaptive, blending YOY giant sea bass into the surrounding detritus. These attributes, coupled with their preferred habitat of shallow, soft bottomed, and featureless flats just outside the wave base of sandy beaches (not frequented by divers) is perhaps why there were so few sightings of the YOY giant sea bass in the past. Using SCUBA transects, we were able to document for the first time the early ecology of the YOY giant sea bass *(c.f.* Benseman and Allen 2018).

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The specific goals of this contribution were to describe, in detail, the diurnal behavior that these YOY giant sea bass exhibit after recruitment and their use of those adaptations to facilitate predator avoidance and mobility under varying degrees of surge during the diurnal hours.

Materials and Methods

We chose five sites that yielded the highest probability of locating YOY giant sea bass for our behavioral observations (Benseman and Allen 2018). These locations included soft sandy beach bottoms areas near the heads of submarine canyons (Allen et al. 2018). These were Veterans Park in the City of Redondo Beach (33° 50′ 10.42″N, 118° 23′ 30.06″W), Newport Pier, off Newport Beach (33° 36′ 26.63″N, 117° 55′ 54.80″W), and La Jolla Shores in San Diego (32° 51′ 19.63″N, 117° 15′ 45.03″W) off southern California.

We amassed over 220 biologist hours of focused bottom time on SCUBA during the months when we expected YOY giant sea bass to be present, from July 2013 through February 2018. SCUBA observations were conducted during the daylight hours (0800-1700) at depths ranging from 2-18 meters. Diving observations were made about every 1-3 weeks at rotating locations as weather, schedules, and water conditions allowed. The first behavior seen at initial contact for each individual was recorded. We documented the behavior of 80 individuals on video with a GoPro© Hero 3 for 1-4 minutes.

Results

The diurnal behavior of YOY giant sea bass is yet another heretofore undescribed aspect of the early life history of the giant sea bass, so we separated the most frequently observed behaviors into the categories we referred to as 1) “kelping”, 2) “resting”, 3) “traveling”, 4)“feeding”, and 5) “burying”. The three most common diurnal behaviors observed were “kelping” (Fig. 1), where the individual camouflages itself matching the form and movement of vegetation fragments, “resting” where the individual remained in place without accompanying vegetation or detritus, and “traveling” (Fig. 2), where the individual slowly moved 1 to 2 cm just above the sand. In Benseman and Allen (2018) and Couffer (2017), we documented three distinct color phases of YOY giant sea bass: black, brown, and orange, ranging from 10 to 185 mm TL and described the morphology of each phase in detail. Kelping behavior was the most frequent behavior encountered and was most commonly associated with the larger orange phase fish ($X^2 = 10.24$, $p = 0.03$; Fig. 3) which makes sense because they are the largest and most conspicuous of the three phases. As first described by Couffer and Benseman (2015), burying behavior was also witnessed, where an individual that was startled, turned on its side, undulated like a flatfish, and completely buried itself under the soft sandy bottom substrate (Fig. 4).

Kelping behavior (Fig. 1) undoubtedly functions as a predator avoidance mechanism, and perhaps secondarily, as an energy-saving behavior. YOY giant sea bass mimic scattered fragments of vegetation attached to the benthos or trapped against small-stationary objects such as solitary protruding worm tubes. Kelping always involved an individual orienting to a single isolated fragment or very small clump of algae. YOY giant sea bass appeared to prefer frond fragments of giant kelp, which are relatively common within the nursery areas, but they would also “kelp” against various other fragments of algae, small solitary tangles of dead surf grass, and in one instance, a piece of PVC tubing. White spots on the sides of the YOY of giant sea bass may mimic the white patches of bryozoans that are often sparsely

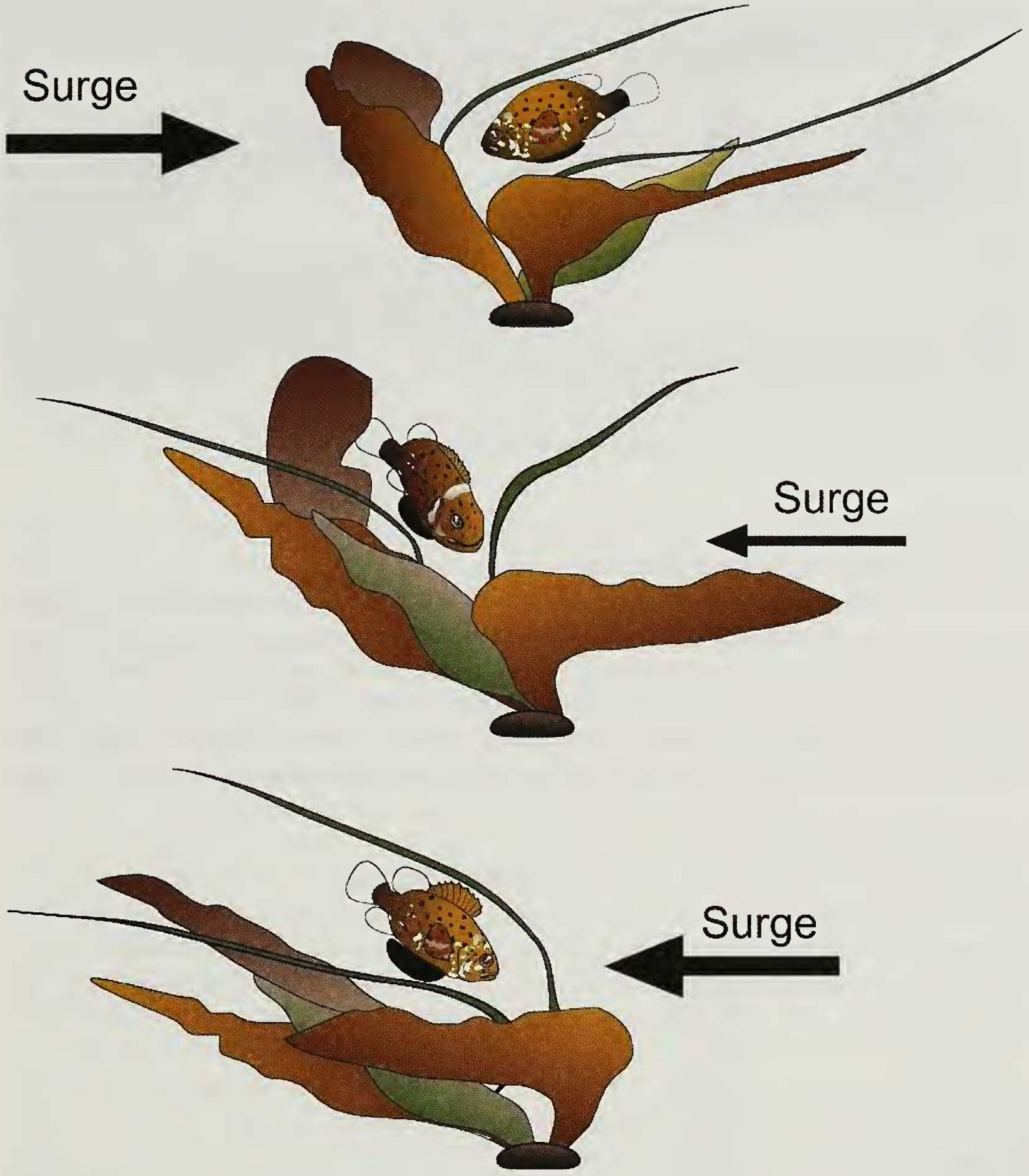

Fig. 1. Diagrammatic representation of "kelping" behavior with both vegetation and fish orienting to reversing surge. Drawn from video by LGA.

scattered across older kelp fronds and other objects. The fish usually stationed themselves next to a piece of kelp or detritus similar in size to the individual, and held position against the surge by swimming back and forth as the direction of surge changed, turning into the oncoming current and then back in the other direction as the surge direction switched (Fig. 1).

Contrary to earlier thought, YOY giant sea bass were not normally associated with sand dollar (*Dendraster excentricus*) beds. Out of 160 individuals observed during the 220 hours of observation, only two were observed in sand dollar beds. One was swimming across a bed, and the other was holding station next to a sand dollar. Moreover, YOY giant sea

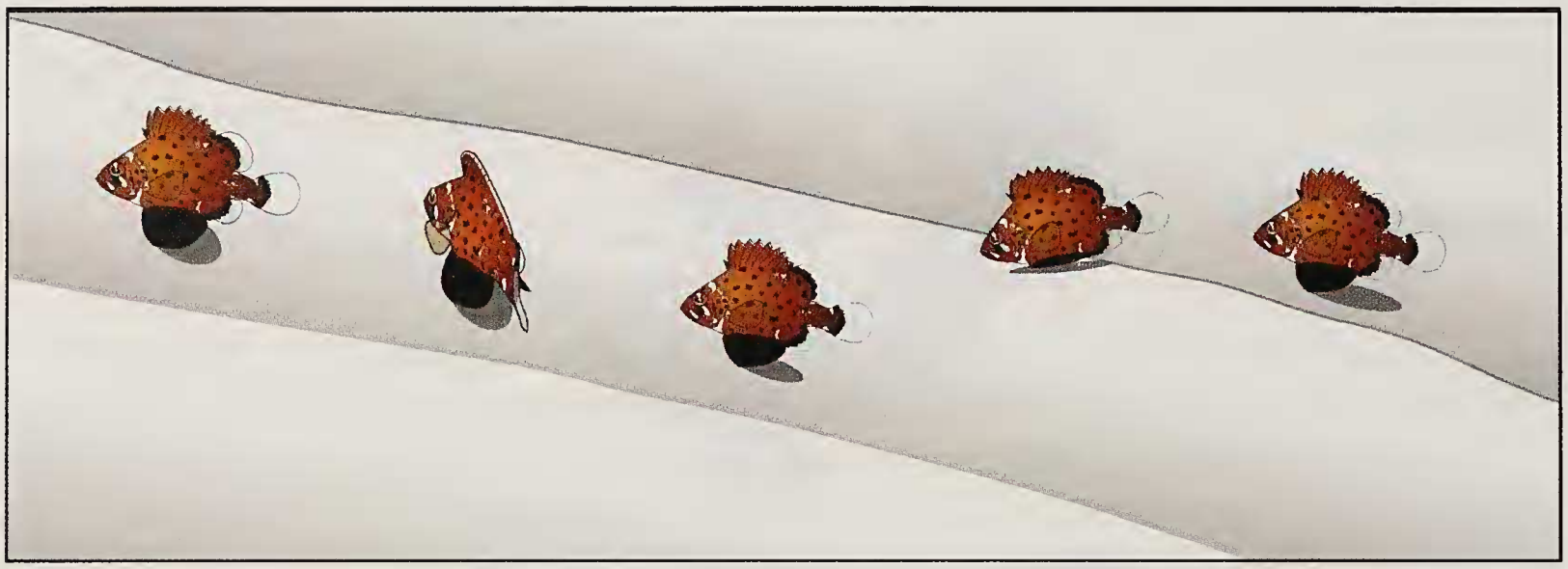

Fig. 2. Diagrammatic representation of the behaviors termed "traveling" (fish is portrayed moving right-to-left across the image). Drawn by LGA from video.

bass did not use long strands or isolated clumps of algae or artificial objects (e.g. lengths of rope or chain) for "kelping" behavior.

"Resting" behavior was similar to "kelping", because it also entailed holding position, appeared to be a predator avoidance mechanism, as well as an energy-saving device. Resting YOY giant sea bass were neutrally buoyant and found maintaining station about a centimeter or so off the bottom with dorsal and pelvic fins sometimes depressed and, at other times extended. YOY giant sea bass would "rest" a few centimeters above flat or gradually sloping bottom in areas of little to no surge. Depressions chosen by YOY giant

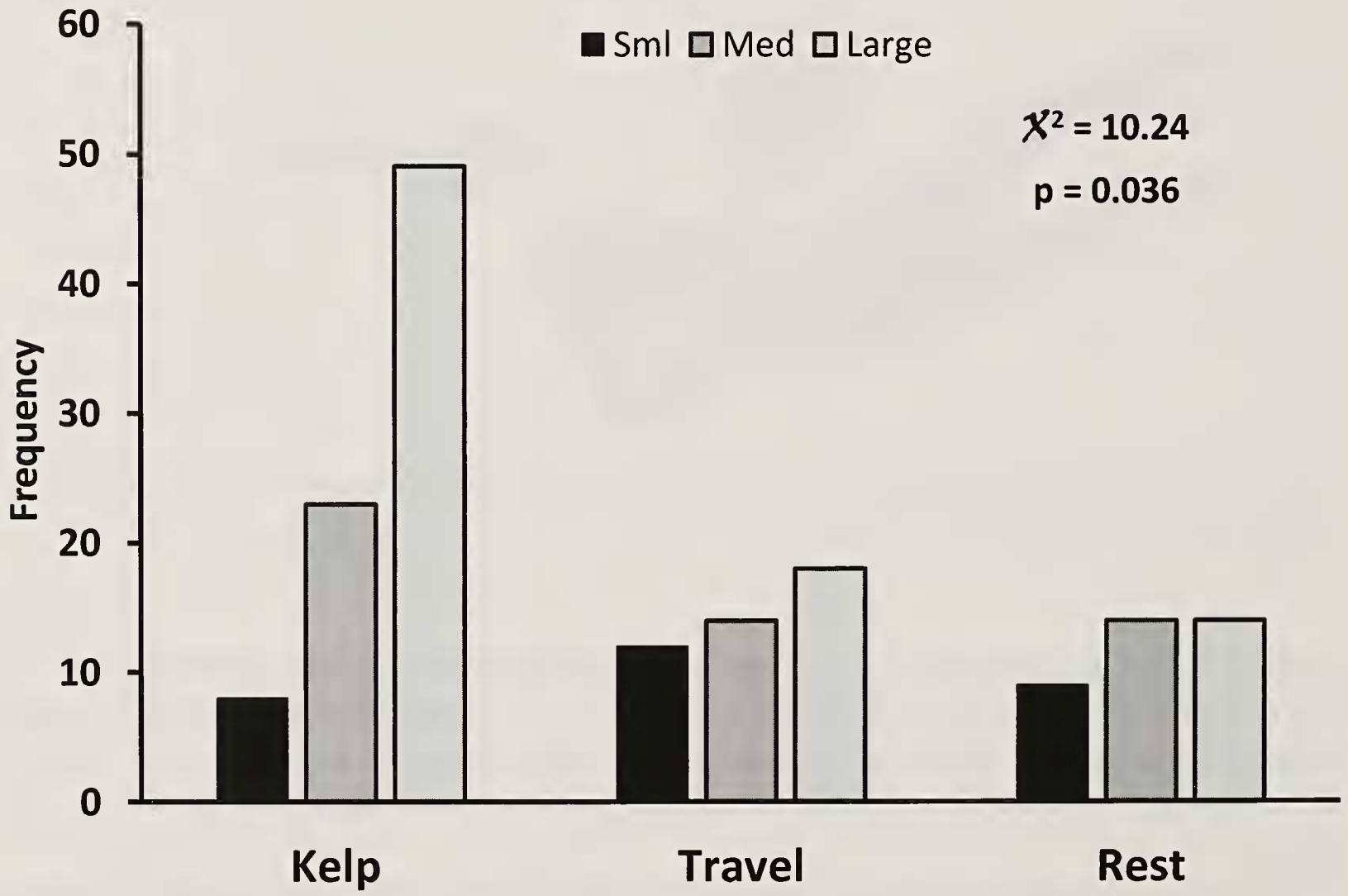

Fig. 3. The total abundances of individual young-of-the-year of *Stereolepis gigas* seen, displaying each of three behaviors at the time of sighting. Black bars represent the smaller black phases, brown bars represent medium-sized brown phases, and orange bars represent the larger orange fish.

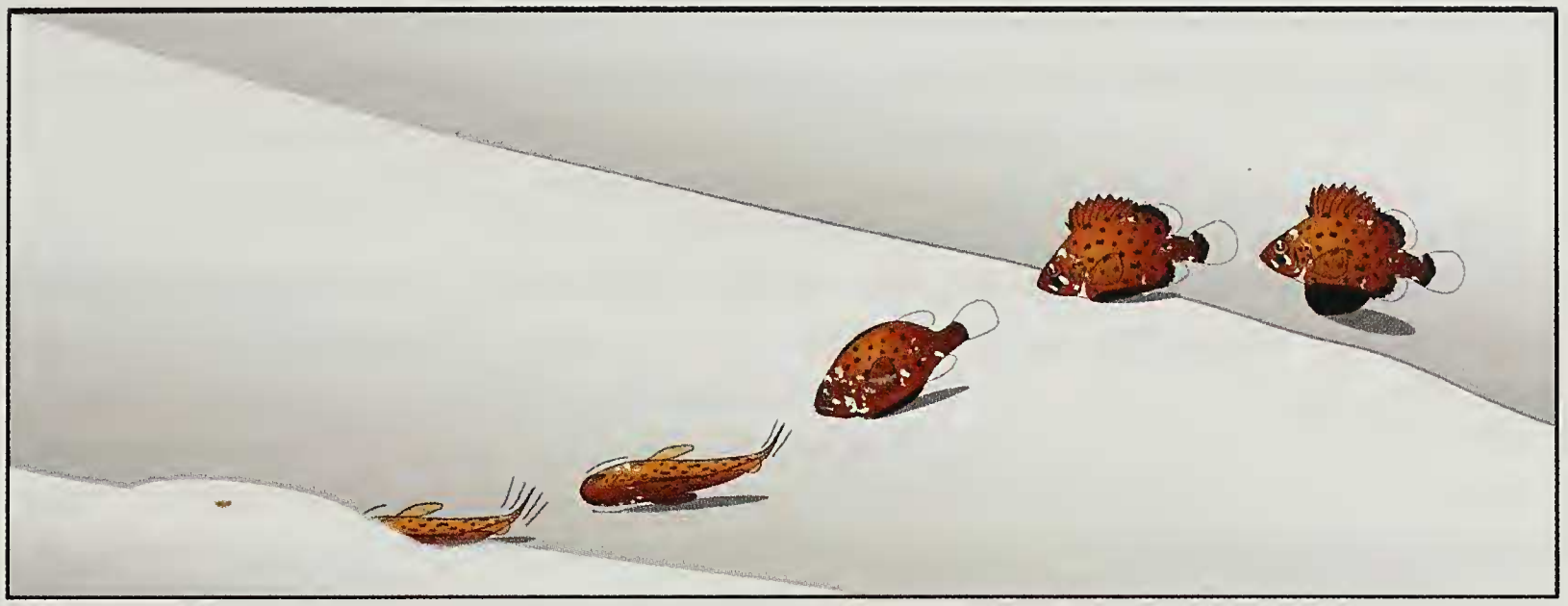

Fig. 4. Diagrammatic representation of "burying" behavior (as per Couffer and Benseman 2015).

sea bass for resting were always small, sometimes not much larger than the fish itself, but rarely larger than 30 cm across. YOY giant sea bass probably use small depressions as shelter from the near-shore surge caused by wave action, however, fish were also detected using small depressions in deeper water where there was little to no surge present. We did observe instances where fish rested in a depression even though appropriately sized detritus fragments that could have been used for kelping was scattered across the bottom. We observed fish maintaining resting postures over long periods of time. One 20 mm black-phase fish that was not disturbed by the observer hovered a centimeter or so above the bottom of the same 30 cm sand depression for over four hours during the middle of one day. That fish was surrounded by many depressions of similar depth and width. On rare occasions, an individual could be startled from its resting location and dart away quickly, but usually the fish would casually drift away as if imitating the shape, color, and movement of a detached piece of drift kelp. On occasion, resting behavior was abandoned when an observer approached. The fish would then slowly abandon the resting behavior and start to drift away, switching to the "traveling" behavior.

The behavior termed "traveling" (Fig. 3) was where an individual was observed moving a few centimeters above the bottom in a slow, steady fashion. The fish used its dorsal and large pelvic fins as steering rudders to "sail" across the bottom, extending, retracting, or angling the fins independently. The fish sometimes extended a pelvic fin and dragged it across the soft sandy substrate as it swam.

YOY giant sea bass usually drift or travel with the head angled downward, and with quick forward movements, ingesting individual mysid shrimps. Thus, they were observed to employ suction feeding, as the adults of many fishes are known to practice (Gerking 2014). Feeding behavior was observed sporadically during most observations of the previously described behaviors. The final behavior was categorized as "burying" (Fig. 4), where an individual YOY giant sea bass that was threatened by the approach of a diver completely buried itself in sandy bottom as a probable predator avoidance mechanism (Couffer and Benseman 2015). This behavior, while dramatic, was observed only on a single occasion.

On numerous occasions, we witnessed large swarms of Opossum shrimp or mysid shrimp (*Amathimysis trigibba*) within the YOY giant sea bass nursery areas. We were able to photograph and video-record these feeding behaviors many occasions. As previously reported

(Benseman and Allen 2018), we confirmed through gut content analysis that no other food item occurred more frequently in the 35 YOY giant sea bass guts examined.

Discussion

Previous studies described the larvae of giant sea bass as being heavily pigmented with both black and yellow chromatophores, having well developed fins, a rounded caudal fin, and undergoing several pigmentation phases (Shane et al. 1996), but they did not go into specific details about pigmentation. The orange, sometimes brick red-pigmented, phase described herein has been seen and photographed most often by citizen scientist divers, possibly because these fish are the most conspicuous due to their brighter color under dive lights and their larger size. Brown phase individuals are smaller than those in the orange phase are. They are less recognizable as a YOY giant sea bass and have been photographed on only a few occasions. Black phase fish are smaller still and very cryptic in appearance. Black phase individuals spent a lot of their time traveling and, at first glance, appeared as nothing more than a speck of detritus drifting in the surge. This is probably why the black phase has not been described in the wild before. That coupled with the fact that both the black and brown phases transition into the orange phase relatively quickly (Benseman and Allen 2018). Regardless of the specific color phase (black, brown, or orange) exhibited by the individual YOY giant sea bass, as our videos revealed, the attenuation of light wavelengths at depth rendered all the brown and orange phased individual YOY giant sea bass to be a typical greenish-gray color much the same as that of surrounding kelp fragments and detritus. Thus, the pigmentation of YOY giant sea bass matches their immediate surroundings and is a form of crypsis. Furthermore, the white spots on the sides of orange-phase YOY giant sea bass appear to mimic the white patches of bryozoans that are often sparsely scattered across older kelp fronds. Crypsis has been shown as a highly successful anti-predator strategy across many taxa of marine and terrestrial animals (Endler 1978, Merilaita et al. 1999).

The soft sandy benthos that surrounds these underwater canyons have been found to be successful nursery areas for giant sea bass because they are replete with small prey (Dahl 1952) and relatively devoid of predators (McLachlan 1990) especially when compared with crowded kelp forests and rocky reefs. This soft benthos offers little physical protection from visual predators yet may provide cover from predators through burying behavior. Burying is a common behavior in many teleost species, but not in quite the same manner. Senoritas, *Oxyjulis californica*, also bury themselves to avoid predation, but typically only at night and not in direct response to an approaching predator (Hobson 1965). Flatfish will also bury themselves to ambush unsuspecting prey, but usually the head and/or operculum remains unburied (Gibson & Robb 1991). However, this YOY giant sea bass completely submerged beneath the sediment and only a small section of scales could be seen (Fig. 7). This unique combination of adaptations could allow for them to hide in plain sight, but when necessary, to take refuge in the sediments and wait for the predator to abandon pursuit.

"Kelping" is probably an adaptation to the bare environment and it allows the YOY giant sea bass to hide in plain sight and avoid predation during these early developmental periods. The color of the kelp present varies from browns to oranges with scattered small white bryozoan patches, just like the coloration of YOY giant sea bass under natural underwater light. This behavior helps them to blend into the bare sandy bottom surroundings and avoid predation. In fact, they are so successful at this strategy that on numerous

occasions, divers preforming surveys overlooked fish, moving past or over the top of "kelping" fish only to be shown their mistake by the accompanying diver. Fish appeared to feed most often when traveling. The YOY giant sea bass usually travel slowly with the head angled downwards, and then with quick forward movements snap up individual mysid shrimps, after which they usually continued swimming with the current and not appearing to expend much energy. They would extend their dorsal and the enlarged pelvic fins in and out, using the surge to maneuver. The dragging of the enlarged pelvic fins against the substrate probably functioned to establish the distance between the fish and the bottom. This should prove beneficial since this habitat experiences such variable surge patterns and waves.

We believe that the individual was stabilizing itself against the surge, similar to a sailor manipulating a sail and dagger board on a sailboat. This action, coupled with the gentle dragging of the enlarged pelvic fins against the substrate while traveling (possibly to establish the distance between the fish and the bottom) could be beneficial since these areas experience such variable surge patterns and waves. Establishing distance from the bottom could prevent injury. This might explain why the pelvic fins are so greatly enlarged at this stage in their life, and are reduced once the has grown into adult form and occupies a less turbulent habitat.

Descriptions of early developmental processes and behavioral patterns are crucial for informing the life history for any species, allowing us to make increasingly intelligent decisions about fisheries management policies and future conservation efforts including the possible protection of nursery sites. In conclusion, we reiterate (as first stated by Couffer 2017, Benseman and Allen 2018, Allen et al. 2018) the importance of conserving these shallow nearshore sandy areas of the Southern California Bight, especially those opposite and adjacent to submarine canyons, as YOY nurseries that must be protected against sand replenishment and other anthropogenic disturbances of the benthos. Finally, this study is the first of its kind to provide a behavioral overview of the YOY of this internationally listed endangered species, and it bridges important gaps in our understanding of their life history. For the first time, we were able to describe the behavior and confirm the diet that are critical to the survival of the young-of-the-year of the critically endangered Giant sea bass off southern California.

Acknowledgements

This project would have not been possible without the effort and support of all our dive buddies who braved the cold to help us search for many hours for the "needle in the haystack". Mike Franklin, Richard Yan, Milton Love, and Mark Steele provided advice and guidance throughout the project. Edward DeMartini provided invaluable comments on an earlier draft of this paper. This research was supported by PADI, the International Women's Fishing Association, Nearshore Marine Fish Research Program, and the Office of Graduate Studies at CSUN. Specimens were collected by authorizations granted by Scientific Collecting Permits #13028 and #00032.

Literature Cited

Allen, L.G., S.A. Benseman, and M.C. Couffer 2018. Baby Giants are found at the heads of submarine canyons. Ecology, 100(1): 1–3.

Benseman, S.A. and L.G. Allen 2018. Distribution and recruitment of young-of-the-year Giant Sea Bass, *Stereolepis gigas*, off southern California. Copeia, 106(2): 312–320.

Cailliet, G. M., M. S. Love, and A. W. Ebeling. 1996. Fishes: their structure, identification and natural history. Waveland Press, Illinois, USA, pp. 149–152.

Couffer, M. C. 2017. Individually unique spot patterns of young of the year Giant sea bass, *Stereolepis gigas* in captive-raised fish. BSCAS, 116(2): 98–109.

Couffer, M.C., and S.A. Benseman. 2015. A young-of-the-year Giant sea bass, *Stereolepis gigas* buries itself in sandy bottom: A possible predator avoidance mechanism. BSCAS, 114(1): 54–57.

Craig, M.T., D.J. Pondella, II, and J.C. Hafner, 1999. Analysis of age and growth in two eastern Pacific groupers (Serranidae: Epinephelinae). Bull. Mar. Sci., 65(3):807–814.

Dahl, E. 1952. Some aspects of the ecology and zonation of the fauna on sandy beaches. Oikos. 4(1):1–27.

Endler, J.A. 1978. A predator's view of animal color patterns. Evolutionary Biology, 11: 319–364.

Gibson, R.N. and Robb, D.L. 1992. The relationship between body size, sediment grain size and the burying ability of juvenile plaice, *Pleuronectes platessa*. L. J. Fish Biol., 40(77):1–778.

Hobson, E.S. 1965. Diurnal-nocturnal activity of some inshore fishes in the Gulf of California. Copeia, 3:291–302.

House, P.H., Clark, L.F.B., and L.G. Allen. 2016. The return of the king of the kelp forest: Distribution, abundance, and biomass of Giant sea bass (*Stereolepis gigas*) off Santa Catalina Island, California, 2014-2015. BSCAS, 115(1):1–14.

Love, M.S. 2011. Certainly More Than You Want to Know about the Fishes of the Pacific Coast: a Post-modern Experience. Really Big Press.

McLachlan, A. (1990). Dissipative beaches and macrofauna communities on exposed intertidal sands. J. Coast. Rsrch., 6(1): 57–71.

Merilaita, S., J. Tuomi, and V. Jormalainen 1999. Optimization of cryptic coloration in heterogeneous habitats. Biological Journal of the Linnean Soc., 67:151–161.

Shane, M.A., W. Watson, and H.G. Moser. 1996. Polyprionidae: Giant sea basses and wreckfishes. Pp. 873–875 in The Early Stages of Fishes in the California Current Region. (H.G. Moser ed.). Coop. Fish. Invest. Atlas No. 33. Allen Press Inc.